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Most Frequently Occurring Classifications of Patents Returned
From A Search of 10696669 on March 25, 2005

Original Classifications

```
3   89/1.13
3  405/288
2  342/357.1
2  367/88
2  405/259.6
2  440/12.5
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Cross-Reference Classifications

```
3  701/213
2   89/1.11
2   89/1.13
2  102/403
2  114/312
2  114/313
2  114/315
2  166/245
2  166/268
2  166/292
2  299/11
2  299/12
2  342/357.06
2  342/357.13
2  405/259.4
2  405/267
2  405/290
2  411/428
2  411/534
2  440/12.66
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Combined Classifications

```
5   89/1.13
3  405/267
3  405/288
3  701/213
2   89/1.11
2  102/403
2  114/312
2  114/313
2  114/315
2  166/245
2  166/261
2  166/268
2  166/292
2  299/1.05
2  299/11
2  299/12
2  342/357.06
2  342/357.1
2  342/357.13
2  367/88
2  405/259.4
2  405/259.6
2  405/290
2  411/428
2  411/534
2  440/12.5
2  440/12.66
2  701/207
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Titles of Most Frequently Occurring Classifications of Patents Returned
From A Search of 10696669 on March 25, 2005

```
5   89/1.13      (3 OR, 2 XR)
       Class    089 :  ORDNANCE
       89/1.13         MINE-DESTROYING DEVICES

3  405/267       (1 OR, 2 XR)
       Class    405 :  HYDRAULIC AND EARTH ENGINEERING
       405/258.1       EARTH TREATMENT OR CONTROL
       405/263         .Chemical
       405/266         ..Cementitious (e.g., grouting)
       405/267         ...Filling substerranean cavity (e.g.,
                          underground wall)

3  405/288       (3 OR, 0 XR)
       Class    405 :  HYDRAULIC AND EARTH ENGINEERING
       405/258.1       EARTH TREATMENT OR CONTROL
       405/272         .Shoring, bracing, or cave-in prevention
       405/288         ..Roof support

3  701/213       (0 OR, 3 XR)
       Class    701 :  DATA PROCESSING: VEHICLES, NAVIGATION, AND
                        RELATIVE LOCATION
       701/200         NAVIGATION
       701/207         .Employing position determining equipment
       701/213         ..Using Global Positioning System (GPS)

2   89/1.11      (0 OR, 2 XR)
       Class    089 :  ORDNANCE
       89/1.11         WAGING WAR

2  102/403       (0 OR, 2 XR)
       Class    102 :  AMMUNITION AND EXPLOSIVES
       102/401         MINES
       102/402         .Counter measure
       102/403         ..By explosion

2  114/312       (0 OR, 2 XR)
       Class    114 :  SHIPS
       114/312         SUBMERSIBLE DEVICE

2  114/313       (0 OR, 2 XR)
       Class    114 :  SHIPS
       114/312         SUBMERSIBLE DEVICE
       114/313         .With disparate vehicle feature

2  114/315       (0 OR, 2 XR)
       Class    114 :  SHIPS
       114/312         SUBMERSIBLE DEVICE
       114/315         .Diver assistance device

2  166/245       (0 OR, 2 XR)
       Class    166 :  WELLS
       166/244.1       PROCESSES
       166/245         .Specific pattern of plural wells

2  166/261       (1 OR, 1 XR)
       Class    166 :  WELLS
       166/244.1       PROCESSES
       166/256         .In situ combustion
       166/261         ..Injecting specific material other than oxygen
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into formation

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2  166/268        (0 OR, 2 XR)
     Class    166 :  WELLS
     166/244.1       PROCESSES
     166/268         .Distinct, separate injection and producing
                        wells

2  166/292        (0 OR, 2 XR)
     Class    166 :  WELLS
     166/244.1       PROCESSES
     166/285         .Cementing, plugging or consolidating
     166/292         ..Using specific materials

2  299/1.05       (1 OR, 1 XR)
     Class    299 :  MINING OR IN SITU DISINTEGRATION OF HARD
                       MATERIAL
     299/1.05        AUTOMATIC CONTROL; SIGNALING OR INDICATING

2  299/11         (0 OR, 2 XR)
     Class    299 :  MINING OR IN SITU DISINTEGRATION OF HARD
                       MATERIAL
     299/10          PROCESSES
     299/11          .Stabilizing underground structure

2  299/12         (0 OR, 2 XR)
     Class    299 :  MINING OR IN SITU DISINTEGRATION OF HARD
                       MATERIAL
     299/10          PROCESSES
     299/12          .Mine safety

2  342/357.06     (0 OR, 2 XR)
     Class    342 :  COMMUNICATIONS:  DIRECTIVE RADIO WAVE SYSTEMS
                       AND DEVICES
     342/350         DIRECTIVE
     342/352         .Including a satellite
     342/357.01      ..With position indicating
     342/357.06      ...Using Global Positioning Satellite (GPS or
                        Glonass)

2  342/357.1      (2 OR, 0 XR)
     Class    342 :  COMMUNICATIONS:  DIRECTIVE RADIO WAVE SYSTEMS
                       AND DEVICES
     342/350         DIRECTIVE
     342/352         .Including a satellite
     342/357.01      ..With position indicating
     342/357.06      ...Using Global Positioning Satellite (GPS or
                         Glonass)
     342/357.1       ....Combined with telecommunication

2  342/357.13     (0 OR, 2 XR)
     Class    342 :  COMMUNICATIONS:  DIRECTIVE RADIO WAVE SYSTEMS
                       AND DEVICES
     342/350         DIRECTIVE
     342/352         .Including a satellite
     342/357.01      ..With position indicating
     342/357.06      ...Using Global Positioning Satellite (GPS or
                         Glonass)
     342/357.13      ....With storage device (i.e., map or database)


2  367/88         (2 OR, 0 XR)
     Class    367 :  COMMUNICATIONS, ELECTRICAL: ACOUSTIC WAVE
```

SYSTEMS AND DEVICES
367/87 ECHO SYSTEMS
367/88 .Side scanning or contour mapping sonar systems

2 405/259.4 (0 OR, 2 XR)
Class 405 : HYDRAULIC AND EARTH ENGINEERING
405/258.1 EARTH TREATMENT OR CONTROL
405/259.1 .Rock or earth bolt or anchor
405/259.4 ..Bolt having wedge expander

2 405/259.6 (2 OR, 0 XR)
Class 405 : HYDRAULIC AND EARTH ENGINEERING
405/258.1 EARTH TREATMENT OR CONTROL
405/259.1 .Rock or earth bolt or anchor
405/259.5 ..With settable material feature
405/259.6 ...Breaking canister or packet

2 405/290 (0 OR, 2 XR)
Class 405 : HYDRAULIC AND EARTH ENGINEERING
405/258.1 EARTH TREATMENT OR CONTROL
405/272 .Shoring, bracing, or cave-in prevention
405/288 ..Roof support
405/290 ...Jack

2 411/428 (0 OR, 2 XR)
Class 411 : EXPANDED, THREADED, DRIVEN, HEADED, TOOL-DEFORMED, OR LOCKED-THREADED FASTENER
411/427 INTERNALLY THREADED FASTENER ELEMENT, E.G., NUT, ETC.
411/428 .Including lubricating means

2 411/534 (0 OR, 2 XR)
Class 411 : EXPANDED, THREADED, DRIVEN, HEADED, TOOL-DEFORMED, OR LOCKED-THREADED FASTENER
411/531 WASHER STRUCTURE
411/534 .Including antifriction means

2 440/12.5 (2 OR, 0 XR)
Class 440 : MARINE PROPULSION
440/12.5 SELF-PROPELLED VEHICLE HAVING LAND AND WATER PROPULSION MEANS (E.G., AMPHIBIOUS VEHICLE)

2 440/12.66 (0 OR, 2 XR)
Class 440 : MARINE PROPULSION
440/12.5 SELF-PROPELLED VEHICLE HAVING LAND AND WATER PROPULSION MEANS (E.G., AMPHIBIOUS VEHICLE)
440/12.66 .Wheel-type propulsion means

2 701/207 (1 OR, 1 XR)
Class 701 : DATA PROCESSING: VEHICLES, NAVIGATION, AND RELATIVE LOCATION
701/200 NAVIGATION
701/207 .Employing position determining equipment

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... performs it's mission, observed from two points of view-the overhead camera used
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Pemex-PE Portrait Gallery
... **Mine** Explorer (Pemex) BE is a two-wheeled **robot** built to ... will be tested for the detection
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Biomimetic Underwater **Robot** Program
... Motion Video for Scientific **Image** Analysis. ... and Massa, D. (1994) Biologically-Based
Underwater **Robots**. ... the Autonomous Vehicles in **Mine** Countermeasures Symposium ...
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Army Technology - Explosive Ordnance Disposal and **Mine** Clearance ...
... and implemented upgrades for the Ground Standoff **Mine** Detection System ... A security
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> ... service in the Falklands and Bosnia as **mine** clearance vehicles. ... Expand **image** Andros
> F6-A: a highly reliable and versatile multi-mission mobile **robot**. ...
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... such as text **mining**, web **mining**, **image mining**, and sensors. ... **Mine** the data for knowledge
discovery, user ... a combination of layers constitutes a micro **robot**. ...
www.rit.edu/~ficwww/RIT_Research_Capabilities.pdf - Similar pages

Range **Image** Registration and **Robot** Relocalization
... 6D **robot** relocalization is essential for **robots** driving cross ... distinguishing features
of the range **images** and uses ... the surface structure of the **mine** is too ...
www.ais.fraunhofer.de/ ARC/3D/download/icra2004/node4.html - 6k - Cached - Similar pages

Have an Old **Mine**? Build your Rover to Explore it!
... a pan-and-tilt video camera that will be able to send **images** of the **mine** back to ...
let's turn to the Tucson Citizen to learn more about why this **robot** is a ...
www.primidi.com/2004/12/04.html - 26k - Cached - Similar pages

Low-Cost **Robot** Could Locate Land **Mines** In Rugged Terrain
... a spray paint nozzle to mark the spot when a possible **mine** is located ... also features a small video screen displaying real-time **images** from the **robot's** camera ...
www.spacedaily.com/news/**robot**-04p.html - 23k - Cached - Similar pages

Roland Piquepaille's Technology Trends

How new technologies are modifying our way of life

samedi 4 décembre 2004

Have an Old Mine? Build your Rover to Explore it!

Here is a story for your weekend. The grandmother of an engineering student at the University of Arizona has an old mine on her property. What could be inside? Would it be safe to explore it? She -- the student, not the grandmother -- decided it was better to send a robot inside and she teamed with another robotic enthusiast to build **a radio-controlled rover to explore the mysteries of the old mine**. The 18-inch-long and 7-inch-high robot can communicate with them via a 900 MHz radio modem and send them videos from inside the mine. Theoretically, the robot has a seven-mile range line-of-sight, but the team is not so sure. So the robot is also tied with a rope to pull it out of the mine if necessary, especially if it falls into a big hole. And did I mention **this robot is a 'she'**? They decided the machine was female "because the rover is independent, sometimes unpredictable and able to do the seemingly impossible" and they called her "Green Meanie." Read more...

Let's start with the beginning of the article of the *Arizona Daily Wildcat*.

> Keith Brock and Jessica Dooley, both aerospace engineering seniors, were curious about what was inside a mine northeast of Phoenix near Congress, Ariz., but were not willing to risk their lives to find out.
>
> Brock and Dooley, members of the UA's Aerial Robotics Club, said they were familiar with the technology necessary to make the rover, so it only took two weeks to go from an idea to the finished product.
>
> Dooley said they have yet to test the rover in an actual mine because they are uncertain how safe the mineshafts are and unsure if they will get radio transmission that far underground. They plan to connect the rover to a rope in case they need to pull it out of the mine.

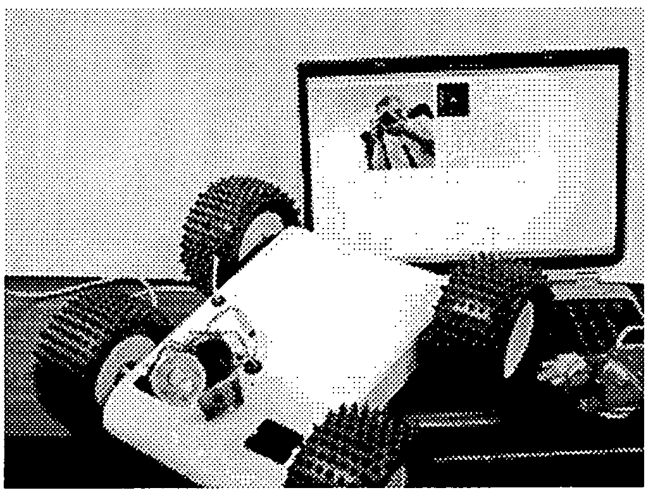
Here is a photo of Keith Brock and Jessica Dooley with their "Green Meanie" rover --

December 2004

Sun	Mon	Tue	Wed	Thu	Fri
			1	2	3
5	6	7	8	9	10
12	13	14	15	16	17
19	20	21	22	23	24
26	27	28	29	30	31

Nov Jan

definitively a 'female' machine (Credit: Gary Gaynor, Tucson Citizen).



And here is how "the mine rover captures a video image of the photographer taking its photo. The photographer's image has been sent from the rover camera (black object just to the right of the light at the front of the rover) to the computer screen." (Credit: University of Arizona?)

Here are some general details about this robotic rover.

> Dooley said the 18-inch-long rover has a searchlight powerful enough to see in the depths of the mine, and a pan-and-tilt video camera that will be able to send images of the mine back to their laptop.
>
> Brock said the rover is 1.5 square feet in area and seven inches tall. He said it can be controlled with a joystick, computer mouse, or cursor tracking.
>
> Brock said the rover is 1.5 square feet in area and seven inches tall. He said it can be controlled with a joystick, computer mouse, or cursor tracking.

Now, let's turn to the *Tucson Citizen* to learn more about why this robot is a 'she.'

> It climbs over rocks as big as your head and remains

> agile on loose gravel, sand and hardpan. It can explore areas too dangerous for humans, lighting its way and sending video images to it creators. It's the Green Meanie.
>
> That's what Jessica Dooley dubbed the green-wheeled, battery-operated rover she built with the help of Keith Brock, a fellow aerospace engineering senior at the University of Arizona. She's decided the machine is female.
>
> "It's definitely a she," Dooley said, explaining that the rover is independent, sometimes unpredictable and able to do the seemingly impossible.

Now that we know that this over is female, let's look at more technical details provided by *innovations report*, from Germany, in "**Students Build Rover to Explore Old Mines**."

> The rover is about 1.5 square feet in area and seven inches tall. It can be controlled with a joystick, computer mouse or cursor tracking. The cursor tracking or "mouse tracking" is linked to the rover's video camera. Move the cursor to a point on the image sent back from the video camera, and the video camera will center over that part of the image where the cursor lies. "If you have a moving object, you can follow it with the mouse and the camera will automatically stay centered on it," Brock said.
>
> With the hatch off, the rover electronics can be seen to include: lithium polymer batteries; servos that drive the wheels; a 900 MHz wireless modem; a servo-driver board that allows the remote computer to send signals to the servos; and a DC-to-DC converter that has outputs for several voltages to power the rover's various electronic components.

So you have an old mine close to your home and want to see what's inside? Contact the students and build your own 'Green Meanie.'

Sources: Georgeanne Barrett, Arizona Daily Wildcat, November 23, 2004; Larry Copenhaver, Tucson Citizen, December 3, 2004; innovations report, Germany, November 18, 2004

Related stories can be found in the following categories.

- **Robotics**
- **Wireless**

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CAMPUS NEWS

Engineering students construct mine rover

By Georgeanne Barrett
Arizona Daily Wildcat
Tuesday, November 23, 2004
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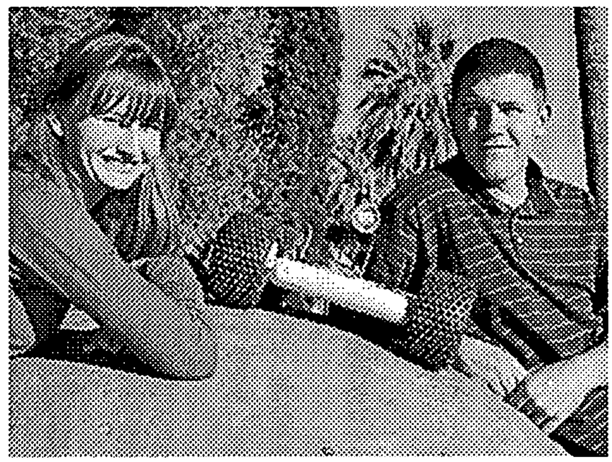

EVAN CARAVELLI/Arizona Daily Wildcat

Senior aerospace engineering majors Jessica Dooley (left) and Keith Brock take a break from testing their mine rover's rock climbing abilities outside the Flandrau Center last week. The rover is capable of transmitting wireless video feed from the depths of a mineshaft back to the surface.

Two UA engineering students have built a radio-controlled rover to explore the mysteries inside old mines in the Arizona desert.

Keith Brock and Jessica Dooley, both aerospace engineering seniors, were curious about what was inside a mine northeast of Phoenix near Congress, Ariz., but were not willing to risk their lives to find out.

Brock and Dooley, members of the UA's Aerial Robotics Club, said they were familiar with the technology necessary to make the rover, so it only took two weeks to go from an idea to the finished product.

Dooley said they have yet to test the rover in an actual mine because they are uncertain how safe the mineshafts are and unsure if they will get radio transmission that far underground. They plan to connect the rover to a rope in case they need to pull it out of the mine.

"My grandma has a mine on her property, and we wanted to make something to go in instead of us," Dooley said. "We are hoping to test it over Thanksgiving."

Dooley said the 18-inch-long rover has a searchlight powerful enough to see in the depths of the mine, and a pan-and-tilt video camera that will be able to send images of the mine back to their laptop.

"We are used to building robotic airplanes," Dooley said. "Building something on the ground is a lot easier."

Brock said the rover is 1.5 square feet in area and seven inches tall. He said it can be controlled with a joystick, computer mouse, or cursor tracking.

"In the beginning, we just wanted to make something silly to go into the mine," Brock said. "The rover wasn't nearly as tricky as the aerial stuff we do."

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Brock said MaxStream, a wireless device networking company, sponsored a large part of the project by providing Brock and Dooley with 900 MHz radio modem that will allow the rover to communicate with a computer outside the mine.

"We were like Tim Allen, we wanted more power for it," Brock said while explaining how they picked out light bulbs for the rover.

Brock said it cost him and Dooley $200 to build the rover. He said $100 of the budget went to buying wheels. The majority of the components came from various parts they had lying around.

"We decided to make the rover from spare parts from our own private stash," Brock said.

Brock said some of the other parts that have made the rover work are servos, mechanisms that drive the wheels, a servo-driver board that allows the remote computer to send signals to the servos, a lithium polymer battery, and a DC-to-DC converter that powers the rover's various electronic parts.

Brock and Dooley originally wanted to put tank tread on the rover, but were unable to find a system that worked.

"It is still in the modification process," Brock said. "It really will never be finished."

Brock and Dooley both said they hope to add to the rover in the future and keep making it better.

They said someday they might add features such as a robotic arm to pick up things out of the mine. They also said they have larger scale future plans for the rover.

"Maybe eventually we could make something for the bomb squad," Brock said. "We could also add features to make it like the Mars rovers."

Dianne Smith, the program coordinator for the Department of Aerospace and Mechanical Engineering, said she thinks it is wonderful Brock and Dooley have been able to develop the rover.

Smith, who has worked with Brock and Dooley for two and a half years, said it is amazing they were able to build this on such a small budget.

"They have done so well and have groomed younger people to follow in the vein they have worked in," Smith said.

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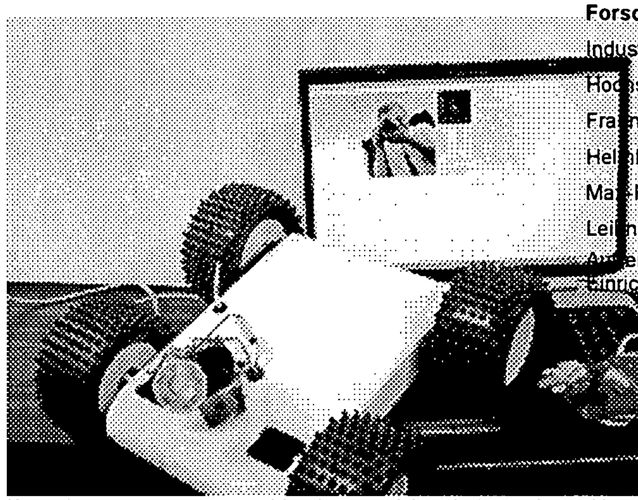
University of Arizona

18.11.2004

Students Build Rover to Explore Old Mines

Abandoned mines — remnants of Old West mining booms — closely guard their secrets in the forgotten corners of Arizona's backcountry.



The mine rover captures a video image of the photographer taking its photo. The photographer's image has been sent from the rover camera (black object just to the right of the light at the front of the rover) to the computer screen.

"What's inside? What's concealed just around that bend in the tunnel?" are the inevitable questions that hikers and others ask when they stumble across these slumbering relics.

Those can be dangerous questions.

Crumbling walls and ceilings that threaten to collapse at the slightest touch; hidden, vertical shafts; poisonous gases; or wildlife lurking inside are just some of the dangers that prevent the non-suicidal from exploring.

Still, the question remains: What's inside?

Two Aerospace Engineering seniors from the University of Arizona have asked that question about a mine near Congress, Arizona — and they're about to find the answer without risking their lives.

They've built an 18-inch-long, radio-controlled rover to do the looking for them. It's equipped with a powerful searchlight to explore the mine's dark recesses and a pan-and-tilt video camera to send images back to their laptop computer.

The mine rover captures a video image of the photographer taking its photo. The photographer's image has been sent from the rover camera (black object just to the right of the light at the front of the rover) to the computer screen.

"Jessica Dooley and I made the ground rover to tour a mine on her grandmother's property," said Keith Brock. "The mine shaft is too small and too dangerous for us to explore ourselves, so we thought

we could make a rover to do it for us. We want to see if there is anything cool inside."

From Concept to Prototype in Three Weeks

Dooley and Brock are veterans of UA's Aerial Robotics Club, which builds robotic airplanes that fly themselves and send back video images of remote targets. With that kind of background, designing and building a ground rover didn't take long — about three weeks, including the time needed to write the software in Visual Basic.

This just-for-fun project is in addition to their full-time engineering studies. Dooley also has a 20-hour-a-week, work-study program at Raytheon and works on research in UA's Lunar and Planetary Laboratory, designing parachutes that will be used to land probes on distant moons and planets. Meanwhile, Brock is on leave from his internship at Raytheon to work on an active-flow-control project in an Aerospace and Mechanical Engineering research lab. That project focuses on finding ways to control aircraft without using moving control surfaces or wing warping. In their "spare time," they're also designing a helicopter autopilot for the Aerial Robotics Club. So how did they fit the mine rover project into their already overloaded schedules? "When you're really passionate about something, you just stay up late," Dooley said.

Getting Into the Technical Details

The rover is about 1.5 square feet in area and seven inches tall. It can be controlled with a joystick, computer mouse or cursor tracking. The cursor tracking or "mouse tracking" is linked to the rover's video camera. Move the cursor to a point on the image sent back from the video camera, and the video camera will center over that part of the image where the cursor lies. "If you have a moving object, you can follow it with the mouse and the camera will automatically stay centered on it," Brock said.

With the hatch off, the rover electronics can be seen to include:

- Lithium polymer batteries (red block at the bottom and yellow blocks on the sides)
- Servos that drive the wheels (black boxes next to the red battery)
- A 900 MHz wireless modem (center, under white label)
- A servo-driver board (top left green board) that allows the remote computer to send signals to the servos.
- A DC-to-DC converter (small board at top center) that has outputs for several voltages to power the rover's various electronic components.

The rover communicates with the computer outside the mine through a 900 MHz radio modem that MaxStream donated to the project. It has a seven-mile range line-of-sight and a half-mile range in dense urban areas. Although they haven't tried it yet, Dooley and Brock believe this will give them sufficient power to communicate with the rover around corners in the mine.

But they still plan to tie a cord to the rover, just in case they need to drag it out or if it dives into a hidden, vertical shaft.

Two servos designed for quarter-scale model airplanes drive the rear wheels, which originally were intended for radio-controlled, off-road, model cars. The servos have a 19 inch-pound rating and will

push the rover to a maximum speed of 1.6 mph, although it will rarely move that fast while exploring mines.

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The rover is built entirely from off-the-shelf components, most of which were not intended for use in this kind of project. But a considerable amount of expertise in robotics was needed to assemble them into a functioning rover. With the donated radio modem and other parts that Brock and Dooley had lying around in their well-stocked junk box, they were able to build the robot for about $200. They estimate that building it from scratch with all-new parts would cost about $1,000.

Depending on what they find inside the mine, they may add extra features in the future, such as a winch or robotic arm to drag out artifacts. They also might equip the robot with a grinding tool so that it could scrape away the surface oxidation on rocks to expose fresh rock underneath, much as the Mars rovers are doing now on the Red Planet.

This kind of robot also could have many other uses, Brock noted. It could become a mobile base for model rockets. "You could mount the rocket, then drive it out and launch it," he said. Or you could equip it with chemical or biological sensors to investigate suspicious packages or vehicles.

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18.11.2004 | Ed Stiles | Quelle: UA News | CMS by NETZGUT

Keith Brock (left) and Jessica Dooley with their mine rover and associated hardware.

Students Build Rover to Explore Old Mines

By Ed Stiles
November 08, 2004

Abandoned mines — remnants of Old West mining booms — closely guard their secrets in the forgotten corners of Arizona's backcountry.

"What's inside? What's concealed just around that bend in the tunnel?" are the inevitable questions that hikers and others ask when they stumble across these slumbering relics.

Those can be dangerous questions.

Crumbling walls and ceilings that threaten to collapse at the slightest touch; hidden, vertical shafts; poisonous gases; or wildlife lurking inside are just some of the dangers that prevent the non-suicidal from exploring.

Still, the question remains: What's inside?

NOTAE

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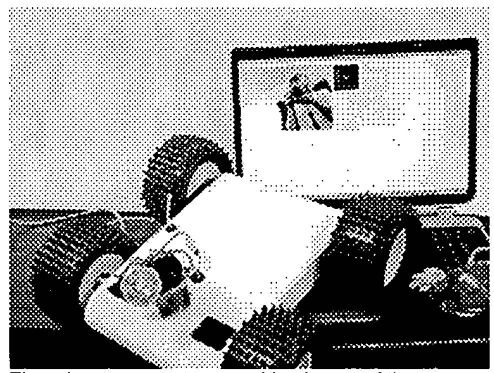
Two Aerospace Engineering seniors from the University of Arizona have asked that question about a mine near Congress, Arizona — and they're about to find the answer without risking their lives.

For Mac/PC/Unix

For Palm OS

They've built an 18-inch-long, radio-controlled rover to do the looking for them. It's equipped with a powerful searchlight to explore the mine's dark recesses and a pan-and-tilt video camera to send images back to their laptop computer.

"Jessica Dooley and I made the ground rover to tour a mine on her grandmother's property," said Keith Brock. "The mine shaft is too small and too dangerous for us to explore ourselves, so we thought we could make a rover to do it for us. We want to see if there is anything cool inside."


The mine rover captures a video image of the photographer taking its photo. The photographer's image has been sent from the rover camera (black object just to the right of the light at the front of the rover) to the computer screen.

From Concept to Prototype in Three Weeks

Dooley and Brock are veterans of UA's Aerial Robotics Club, which builds robotic airplanes that fly themselves and send back video images of remote targets. With that kind of background, designing and building a ground rover didn't take long — about three weeks, including the time needed to write the software in Visual Basic.

This just-for-fun project is in addition to their full-time engineering studies. Dooley also has a 20-hour-a-week, work-study program at Raytheon and works on research in UA's Lunar and Planetary Laboratory, designing parachutes that will be used to land probes on distant moons and planets. Meanwhile, Brock is on leave from his internship at Raytheon to work on an active-flow-control project in an Aerospace and Mechanical Engineering research lab. That project focuses on finding ways to control aircraft without using moving control surfaces or wing warping.

In their "spare time," they're also designing a helicopter autopilot for the Aerial Robotics Club.

So how did they fit the mine rover project into their already overloaded schedules? "When you're really passionate about something, you just stay up late," Dooley said.

Getting Into the Technical Details

The rover is about 1.5 square feet in area and seven inches tall. It can be controlled with a joystick, computer mouse or cursor tracking. The cursor tracking or "mouse tracking" is linked to the rover's video camera. Move the cursor to a point on the image sent back from the video camera, and the video camera will center over that part of the image where the cursor lies. "If you have a moving object, you can follow it with the mouse and the camera will automatically stay centered on it," Brock said.

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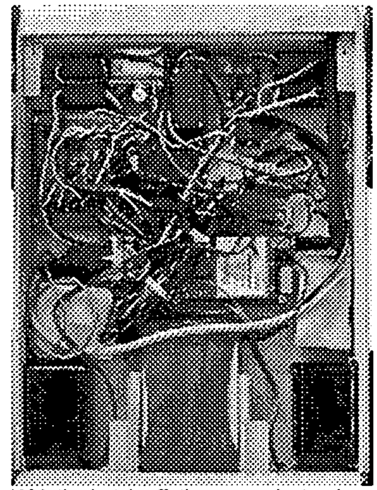

With the hatch off, the rover electronics can be seen to include:
• Lithium polymer batteries (red block at the bottom and yellow blocks on the sides)
• Servos that drive the wheels (black boxes next to the red battery)
• A 900 MHz wireless modem (center, under white label)
• A servo-driver board (top left green board) that allows the remote computer to send signals to the servos.
• A DC-to-DC converter (small board at top center) that has outputs for several voltages to power the rover's various electronic components.

But they still plan to tie a cord to the rover, just in case they need to drag it out or if it dives into a hidden, vertical shaft.

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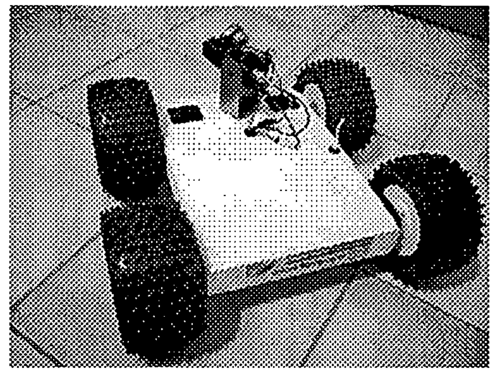

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Roland Piquepaille's Technology Trends

How new technologies are modifying our way of life

samedi 4 décembre 2004

Have an Old Mine? Build your Rover to Explore it!

Here is a story for your weekend. The grandmother of an engineering student at the University of Arizona has an old mine on her property. What could be inside? Would it be safe to explore it? She -- the student, not the grandmother -- decided it was better to send a robot inside and she teamed with another robotic enthusiast to build **a radio-controlled rover to explore the mysteries of the old mine**. The 18-inch-long and 7-inch-high robot can communicate with them via a 900 MHz radio modem and send them videos from inside the mine. Theoretically, the robot has a seven-mile range line-of-sight, but the team is not so sure. So the robot is also tied with a rope to pull it out of the mine if necessary, especially if it falls into a big hole. And did I mention **this robot is a 'she'**? They decided the machine was female "because the rover is independent, sometimes unpredictable and able to do the seemingly impossible" and they called her "Green Meanie." Read more...

Let's start with the beginning of the article of the *Arizona Daily Wildcat*.

> Keith Brock and Jessica Dooley, both aerospace engineering seniors, were curious about what was inside a mine northeast of Phoenix near Congress, Ariz., but were not willing to risk their lives to find out.
>
> Brock and Dooley, members of the UA's Aerial Robotics Club, said they were familiar with the technology necessary to make the rover, so it only took two weeks to go from an idea to the finished product.
>
> Dooley said they have yet to test the rover in an actual mine because they are uncertain how safe the mineshafts are and unsure if they will get radio transmission that far underground. They plan to connect the rover to a rope in case they need to pull it out of the mine.

Here is a photo of Keith Brock and Jessica Dooley with their "Green Meanie" rover --

December 2004

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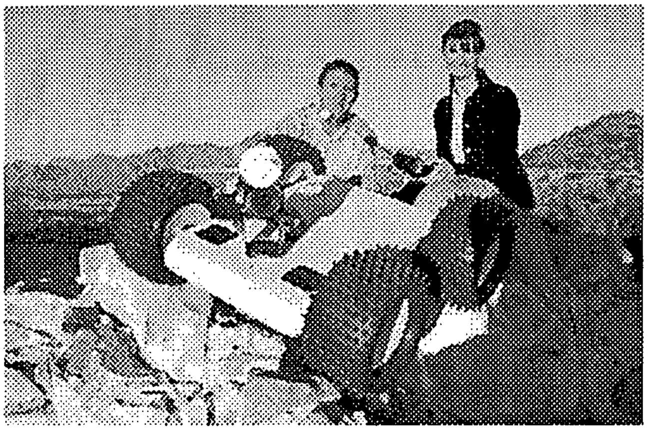
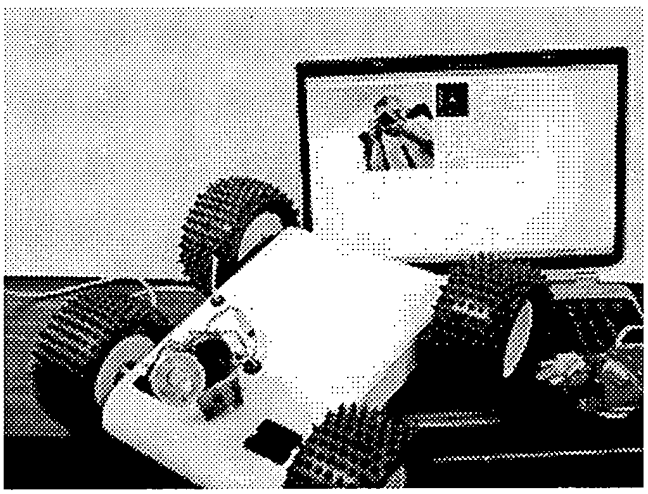


definitively a 'female' machine (Credit: Gary Gaynor, Tucson Citizen).



And here is how "the mine rover captures a video image of the photographer taking its photo. The photographer's image has been sent from the rover camera (black object just to the right of the light at the front of the rover) to the computer screen." (Credit: University of Arizona?)

Here are some general details about this robotic rover.

> Dooley said the 18-inch-long rover has a searchlight powerful enough to see in the depths of the mine, and a pan-and-tilt video camera that will be able to send images of the mine back to their laptop.
>
> Brock said the rover is 1.5 square feet in area and seven inches tall. He said it can be controlled with a joystick, computer mouse, or cursor tracking.
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Now, let's turn to the *Tucson Citizen* to learn more about why this robot is a 'she.'

> It climbs over rocks as big as your head and remains

> agile on loose gravel, sand and hardpan. It can explore areas too dangerous for humans, lighting its way and sending video images to it creators. It's the Green Meanie.
>
> That's what Jessica Dooley dubbed the green-wheeled, battery-operated rover she built with the help of Keith Brock, a fellow aerospace engineering senior at the University of Arizona. She's decided the machine is female.
>
> "It's definitely a she," Dooley said, explaining that the rover is independent, sometimes unpredictable and able to do the seemingly impossible.

Now that we know that this over is female, let's look at more technical details provided by *innovations report*, from Germany, in "**Students Build Rover to Explore Old Mines**."

> The rover is about 1.5 square feet in area and seven inches tall. It can be controlled with a joystick, computer mouse or cursor tracking. The cursor tracking or "mouse tracking" is linked to the rover's video camera. Move the cursor to a point on the image sent back from the video camera, and the video camera will center over that part of the image where the cursor lies. "If you have a moving object, you can follow it with the mouse and the camera will automatically stay centered on it," Brock said.
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So you have an old mine close to your home and want to see what's inside? Contact the students and build your own 'Green Meanie.'

Sources: Georgeanne Barrett, Arizona Daily Wildcat, November 23, 2004; Larry Copenhaver, Tucson Citizen, December 3, 2004; innovations report, Germany, November 18, 2004

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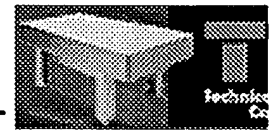
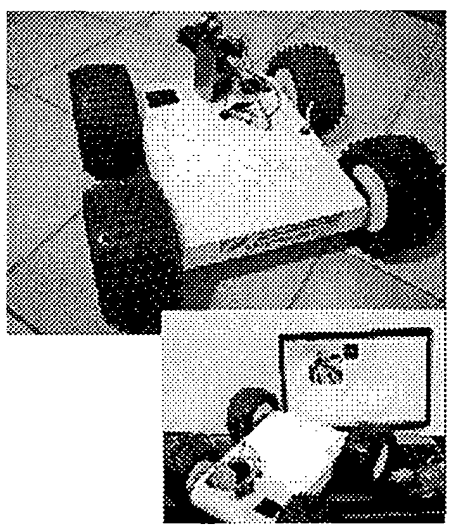


Students Build a Rover for Remote Mine Exploration

Because exploring mines can be dangerous, two students at the University of Arizona in Tucson devised an 18-in.-long, radio-controlled rover to remotely investigate a mine's nooks and crannies. Equipped with a pan-and-tilt video camera and two 12-V halogen lamps, the rover is designed to take images and to transmit them back to a laptop computer.

Jessica Dooley and Keith Brock, aeronautical engineering majors and members of the university's Aerial Robotics Club, are used to building autonomous airplanes outfitted for video imaging. They drew on that expertise to build the rover, which is controlled with a joystick or cursor and which carries a high-resolution video camera, currently an LCL-903K 1/3-in. black-and-white CCD camera from Watec America Corp. of Las Vegas. The camera moves so that it can view approximately 180° horizontally and 90° vertically.



The 18-in. radio-controlled rover is designed to explore old mines with its pan-and-tilt video camera.

The rover communicates with the computer via a 900-MHz RF wireless modem from MaxStream Inc. of Lindon, Utah, which is specified as having a line-of-sight range of seven miles and of 1500 ft indoors or in urban areas. Although they have not yet tested it in a mine, Dooley and Brock hope to be able to communicate with the rover if it stays within those limits. The rover is designed for untethered operation, but they do intend to tie a cord to it in their planned tests in an old mine on Dooley's grandmother's property, just in case.

Powered by three lithium polymer batteries, the rover weighs 3.4 lb and can move at 1.6 mph. The camera is a limitation in the design; the students originally wanted the rover to be able to work right side up or upside down, but with the camera attached to the top, it cannot operate that way. They're exploring the possibility of using a small pinhole

camera such as those used in security systems. Upgrades also may include a winch or arm for extracting artifacts and a grinding tool for scraping the surface of in situ samples to expose fresh rock.

The potential uses for the system extend beyond exploration. If a large enough rover were built, it could be used to transport people or to haul samples out of a mine. Or it could be put to work doing the digging. Aside from mining, the rover could be put to use in other dangerous applications, such as in sensing chemical or biological threats or other surveillance uses.

by Anne L. Fischer

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Carnegie Mellon University 02.06.2003

Carnegie Mellon demonstrates autonomous robot

Explores abandoned mine

Carnegie Mellon University researchers, working with the Pennsylvania Department of Environmental Protection (DEP) and the U.S. Department of Labor's Mine Safety and Health Administration (MSHA), will demonstrate a prototype, autonomous wheeled robot today as it explores and maps a 3,500-foot corridor of an abandoned coal mine near New Eagle in southwestern Pennsylvania.

Named Groundhog, the robot was developed by students in the Robotics Institute's Mobile Robot Development class. It's armed with an array of cameras, gas, tilt and sinkage sensors, laser scanners and a gyroscope to help it surmount the obstacles it will encounter during its unprecedented journey. Typical hazards in an abandoned mine could include roof fall, abandoned equipment and ponded water.

Groundhog will enter the Mathies Mine from a portal near its supply yard and make its way through the darkness to a coal preparation plant more than a half-mile away. The robot travels at a speed of 15 centimeters a second. It will be equipped with a wireless video system that will send back images from the first 500 feet into the mine and, if all goes as planned, from the final 500 feet of its odyssey. Researchers expect that it will take the robot three hours to travel from portal to portal in the mine.

To fulfill its mission, the robot uses perception technology to build maps from sensor data. It must make its own decisions about where to go, how to get there and, more important, how to return safely. Reliable navigation technology is important because of the hazards in abandoned mines. The robot also contains computer interfaces that enable people to view the results of its explorations and use the maps it develops. Groundhog incorporates a technique developed at Carnegie Mellon called Simultaneous Localization and Mapping or SLAM, which enables robots to create maps in real time even as they explore an area for the first time.

"Groundhog has to be ultra reliable because we don't have the option of taking control of it to correct its mistakes," said Robotics Institute Systems Scientist Scott Thayer, who teaches the Mobile Robot Development class with Robotics Institute Fredkin Research Professor William L. Red Whittaker. "The key is our state-of-the-art autonomous exploration and mapping software technology. The robot creates the map, makes its own plan, explores and comes back with useful information."

Groundhog was developed in response to an incident at the Quecreek Mine near Somerset, Pa. last July, when nine miners nearly drowned when they accidentally breached the wall of an

adjacent flooded mine that they thought was a safe distance away from where they were working. Inaccurate maps were cited as a cause of the accident.

Robotics Institute students did a demonstration of Groundhog last fall at a mine near Burgettstown, Pa. The robot, which was on a tether, traveled 150 feet into the facility that had been abandoned since 1920. That expedition proved the feasibility of using mapping technology to explore abandoned mines.

"Because it's autonomous, Groundhog represents one of the real junctions in robotics technology," Whittaker said. "The Groundhog is only the beginning. We see future generations of machines that will swim, crawl and climb through mines to enhance safety, support rescue and ultimately enable robotic operations beyond mining in caves, bunkers, aqueducts and sewers."

The Pennsylvania Department of Environmental Protection has given the Carnegie Mellon researchers a grant to develop another robot called Ferret, a cylindrical device designed to be dropped through boreholes into a void. It uses a laser rangefinder to build 3D maps of an otherwise inaccessible space.

"The Commonwealth is committed to researching new technologies that can help us map abandoned mine workings, and we are pleased to partner with Carnegie Mellon University's Robotics Institute as they explore the possibility of sending a robot in to map the extent of these mine voids," said DEP Acting Secretary Kathleen A. McGinty. "These are areas out of reach to those of us on the surface, but if we can use robotic technology to chart these workings, then we will have gained an invaluable tool in our efforts to protect the miners of the Commonwealth from facing another tragedy such as the Quecreek Mine accident."

More information: www.cmu.edu/

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